SECTION 250.00 – ACCEPTANCE OF MATERIAL ON THE BASIS OF THE RESIDENT ENGINEER'S LETTER OF INSPECTION (FORM ITD-854)

The purpose of form ITD-854, Resident's Letter of Inspection, is for the Resident/Regional Engineer to document the inspection of certain materials and to document the materials are acceptable according to the plans and specifications. In most cases, the inspection of the installation of these items is the most crucial element of the acceptance. The form should not be used as a catchall for items usually accepted by sampling and testing, and inclusion on the form does not excuse the inspector from sampling and testing or obtaining manufacture certifications required by the Minimum Testing Requirements.

The ITD-854 must provide accurate information of the total quantity of material accepted, the source of the material, and the date of the inspection/acceptance of the material. The project files should contain documentation to support the information on the form. The source should identify the manufacturer or fabricator, whenever possible, for future information regarding the material.

The Section 270.00, Minimum Testing Requirement (MTR) tables list materials accepted by the ITD-854. The specifications should be referred to for a complete description of the necessary inspection elements for acceptance of each item. The Resident/Regional Engineer signs the ITD-854 documenting that the items listed on the form have been inspected for acceptance.

SECTION 255.00 – PERFORMANCE GRADED BINDER QUALITY ASSURANCE PLAN

The PG binder supplier is required, as stated in Subsection 702.08 of the Standard Specifications:

- To submit a process control plan to the Engineer and the Central Materials Laboratory for review.
- To certify that all PG binder supplied to the project meets the specified grade when tested in accordance with AASHTO MP-1 and Subsection 702.01 of the Standard Specifications.
- To perform at least one complete set of quality control tests for each 551.15 tons (500 metric tons) of product produced. ITD Central Laboratory may allow, upon request, less frequent testing of large bulk tanks of non-polymerized binder based on the supplier's process control plan.
- To provide a copy of each test report to the Engineer and Central Materials Laboratory.

255.01 Certification. Form ITD-966, PG Binder Supplier's Certification, accompanies the initial shipment of PG binder to the project. Thereafter, this form is furnished for each lot of PG binder shipped to the project. The supplier attaches to the form:

- The Quality Control test results representing the same production lots as PG binder shipped to the project.
- The bill of lading indicating production lots shipped to the contractor.

255.02 Sampling. Each day that plant mix is being produced, a daily binder sample, comprised of three individual one-quart cans, is taken at a random time from the mix plant's asphalt binder tank injection line. Two of these cans will be for ITD's use and the contractor will retain the other can. The sampling method is AASHTO T-40.

Standard Specifications, Section 405.03 – Mixing Plants, provides that "provisions shall be made for measuring and sampling contents of the (PG binder) storage tanks." Be alert the injection line is usually under pressure. The contractor must provide a safe means to obtain the random samples.

When mix plant operations are just starting or after being suspended for more than 48 hours, the sampling sequence will not begin with a completely random sample; instead, this binder sample will be taken near the beginning or resumption of operations.

All samples will be obtained and/or witnessed by a representative of the contractor and ITD, one of which must be WAQTC Asphalt qualified. The sample identification form (ITD-859) will be signed by both parties witnessing the sampling. ITD will take control of two of the cans obtained and the contractor will take control of one can that is retained by the contractor.

255.03 Binder Verification Unit. The quantity of binder used in one week's production of plant mix, except as modified in the remainder of this subsection, shall constitute a binder verification unit. A binder verification unit is comprised of daily binder samples.

If fewer than three daily binder samples are accumulated in a week, group them with the following week's daily binder samples. If this would result in more than seven daily binder samples representing a verification unit, separate into two groups (two verification units), using the approximate center of the plant mix production period as the separation point. If fewer than three daily binder samples are taken in the final week, group them with the previous week's daily binder samples and then separate into verification units as described above.

Under this procedure, the tonnage of binder will normally vary from one verification unit to the next. The number of daily binder samples per verification unit may vary from three to seven. On very small projects (where plant mix production covers only one or two days) there will be only one binder verification unit, represented by one or two daily binder samples.

A binder unit will include only one PG grade. Thus, if the PG grade is changed within a production day, one daily binder sample will be taken for each PG grade used and grouped with other daily binder samples representing the corresponding binder verification unit.

Complete ITD-859, Performance Graded Binder Sample Identification Form. The daily binder sample, comprised of three individual cans, will be labeled with the sample identification numbers, i.e., 2001-C for the first day, 2002-C for the second day, etc. List each daily binder sample identification number and the date sampled on the form. Record the results of Idaho T99, Presence of Anti-Strip, on the form. The test (Idaho T99) for the presence of anti-strip will be performed on at least one of the three cans for each daily binder sample. ITD and the contractor must sign the form for each daily binder sample. The ITD portions of the daily binder samples will be assembled into a binder verification unit and submitted to the Central Materials Laboratory.

The contractor or the supplier may take as many samples as they want for information only. Only the three cans identified as the daily binder sample must be witnessed and signed for by the ITD Inspector.

Inspection or certification of the contractor's storage tank for contamination is the sole responsibility of the contractor.

255.04 Testing. ITD's AASHTO accredited laboratory will randomly choose one daily binder sample from each unit to represent the entire unit and either completely or partially test the selected daily binder sample. If the tested PG grade complies with the specified PG grade properties, the binder unit will be accepted. If the PG grade does not comply with the specified PG grade, additional testing will be performed on the verification unit until the extent of the non-compliant material has been determined. The variations will be subject to the price reduction as specified in the ITD Materials Manual. The price reduction will be applied to the non-compliant material.

255.05 Appeal Procedure. If the contractor wishes to appeal ITD's test results and price reductions, an appeal request must be submitted within 14 calendar days of the reported test results. The appeal must state the grounds or the circumstances of the appeal. If the test results are in question, the appeal must be accompanied by all of the quality control test results that represent the unit in question. The appeal must also be accompanied by contractor-obtained test results for at least one complete PG binder test series conducted on one of the daily binder samples from the unit in question.

The appeal request and the submitted test results will be reviewed by ITD. If the appeal has merit and/or the contractor's PG binder test results from the mix plant differ significantly from ITD's PG binder test results, the appeal will be accepted by ITD.

When an appeal is accepted, ITD will reevaluate the original test results and may conduct additional testing from the unit in question. The initial and additional test results for each specification item will be averaged and the average value for each specification item will be considered the final value. These final values will be used to determine compliance or noncompliance. The contractor will be notified in writing of the additional test results, the final values, and the appeal conclusions.

If the appeal is not accepted, ITD will submit a denial letter to the contractor, stating the grounds for the denial.

The contractor may propose referee testing and choose to have all the backup daily samples retained by ITD, from the binder verification unit in question, tested by an AASHTO accredited laboratory mutually acceptable to the contractor and ITD. All specification parameters in contention will be tested on each daily binder sample. The average result of such tests for a given specification parameter will be the referee value for that parameter. The contractor will agree to bear the costs of the testing if the referee tests verify noncompliance. The AASHTO accredited laboratory will report the results to ITD. The results of such tests will be binding to both parties and any price reduction on the unit in question will be based on those test results.

SECTION 260.00 – MIX DESIGNS

260.01 Plant Mix Pavement (Standard Specification Section 405). This section outlines the mix design review process for Section 405 Plant Mix Pavement found in Subsection 405.03 - A - Mix Design.

260.01.01 Mix Design Requirements and Review Procedure. The Contractor must submit a request for use of materials source(s) to the Resident/Regional Engineer, and if acceptable, its use will be approved in writing. The Contractor must also submit the proposed mix design and all test reports, data, and worksheets used for each trial design attempted to the Resident/Regional Engineer. The Resident/Regional Engineer will submit the data to the District Materials Engineer for review. The Resident/Regional Engineer or District Materials Engineer will send copies of these documents to the Central Materials Laboratory. Preferably, these documents will be scanned by the District and placed on Headquarters Materials Server hqmlsv02, public folder, in the appropriate District folder.

A proposed mix design must be submitted by the Contractor to the Resident/Regional Engineer for review a minimum of five calendar days prior to beginning paving. The design must be prepared and tested by a qualified laboratory. Unless otherwise allowed, all mix designs must be prepared specifically for the project they are submitted for. Designs that do not meet ITD project requirements and specifications will not be accepted. Refer to Subsections 405.02 and 405.03 for the mix design specifications.

The District Materials Engineer will be responsible for reviewing the mix design and making a recommendation, or the mix design may be sent to the Central Materials Laboratory for review and recommendation.

The District Materials Engineer will review the mix design and will make a recommendation to the Resident/Regional Engineer whether the mix design should be used or not. The Resident/Regional Engineer will not approve the design without the positive recommendation of either the District Materials Engineer or the Central Materials Laboratory. The Resident/Regional Engineer will notify the Contractor of the decision and copies of the notification will go to: HQ Materials Engineer, Construction Engineer, Pavement Operations Engineer and the Aggregate and Mix Lab Supervisor. When the review is performed by HQ Materials, a written recommendation will be faxed and/or e-mailed to Resident/Regional Engineer with a copy sent to the District Materials Engineer. The original letter will be mailed with copies to the ADE, District Materials Engineer, Construction Engineer, and HQ Materials distribution.

The Contractor's mix design will either be recommended for use or rejected. If a mix design is rejected, the Resident/Regional Engineer will inform the Contractor of the deficiencies found and a new or adjusted mix design will be required and the five-calendar day review time will start over.

If the Contractor chooses to submit a previously used mix design for review, at a minimum, the following tests must be performed and the results submitted along with the previously used mix design:

1. Current sieve analysis on the stockpiles to be used, including crusher control charts
2. Coarse and fine aggregate specific gravities and absorptions
3. Asphalt binder content correction factor per AASHTO T-308
4. Aggregate gradation correction factors per AASHTO T-308

All previously used mix designs submitted by the Contractor must be forwarded to Central Materials Laboratory for review and recommendation. The decision to accept or reject a previously used mix design rests solely with the Central Materials Laboratory.

The District Materials Engineer is authorized to recommend for use mix designs prepared specifically for the project they are submitted for.

The Contractor or a designated representative must perform a Hveem mix design in accordance with the current version of AASHTO R-12, "Bituminous Mixture Design Using the Marshall and Hveem Procedures." The Asphalt Institute publication "Mix Design for Asphalt Concrete and Other Hot Mix Types," (MS-2), is available from the Asphalt Institute, Executive Offices and Research Building, Research Park Drive, P.O. Box 14052, Lexington, KY 40512-4052. The Contractor's mix design must have a minimum 0.4 percent range of asphalt binder content that meets all specification requirements of Subsection 405.02. The job mix formula (JMF) must specify a single aggregate gradation, a single asphalt content and a maximum theoretical density based on the specified gradation and asphalt content.

The Contractor's mix design submittal to the Resident/Regional Engineer must include the following information:

- Percent of asphalt by Weight of mix, lb./ft^3
- Percent of asphalt by Weight of Aggregates, lb./ft^3
- Air Voids, % (AASHTO T-269)
- VMA, % (Voids in Mineral Aggregate) (see definitions)
- VFA, % (Voids Filled with Asphalt) (see definitions)
- HVEEM Stability Value (AASHTO T-246 & T-247)
- Bulk Specific Gravity, (AASHTO T-166, Method A)
- Theoretical Max Specific Gravity, (Rice Gravity) (AASHTO T-209, Bowl Method)
- Asphalt Film Thickness (AFT) (see definitions)
- Surface Area (see definitions)
- NCAT Ignition Oven Correction Factor (AASHTO T-308)
- Aggregate Gradation Correction Factors (AASHTO T-308)
- Bulk Specific Gravity, dry, (AASHTO T-84 & T-85)
- Fine Aggregate Angularity (Uncompacted Voids Content of Fine Aggregate), (AASHTO T-304, Method A)
- Percent fractured faces (AASHTO TP-61, Method A)
- Percent Flat and Elongated Particles (ASTM D4791)
- Identification of stockpile source(s). (Identify the materials source or sources from where the stockpiles originated. i.e. Coarse stockpile 1 and 2 - Ad 111s, fine stockpile 3 - Ad-53s. Identify and label the stockpiles on the sieve analysis sheet.)
- Proposed Target Gradation
- Type and percent of anti-strip additive
- Immersion Compression test results at 0.5% anti-strip additive or amount required to meet specification. Dry strength, Wet strength and percent retained strength (AASHTO T-165)
- Individual stockpile gradations and blend percentages

- Laboratory Mixing Temp, (from binder supplier)
- Laboratory Compaction Temp, (from binder supplier)
- Recommended Plant Mixing Temp, (from binder supplier)
- Field Compaction Temp Range, (from binder supplier)

The Contractor must provide the following design graphs for the proposed mix design that identifies the proposed JMF and the range of asphalt contents for which the design meets all the specification requirements (see examples). These graphs must be developed using the **percent of asphalt binder by weight of mix.**

- Unit Weight, % binder by weight of mix vs. pcf of mix. (Figures 260.01.03.1A & 260.01.03.2A)
- Maximum Theoretical Unit Weight, % binder (mix) vs. pcf of mix. (Figures 260.01.03.1A & 260.01.03.2A)
- % Air Voids, % binder (mix) vs. % total air voids. (Figures 260.01.03.1B & 260.01.03.2B)
- % VMA, % binder (mix) vs. % voids in mineral aggregate. (Figures 260.01.03.1B & 260.01.03.2B)
- Hveem Stabilometer value, % binder (mix) vs. Stability Value. (Figures 260.01.03.1C & 260.01.03.2C)
- % voids Filled, % binder (mix) vs. Voids filled With asphalt. (Figures 260.01.03.1C & 260.01.03.2C)

The Contractor must provide the JMF plotted on a 0.45 power curve (Figure 260.01.03.3) which includes the maximum density line and control points for the size of aggregate used. The Contractor must ensure the JMF gradation does not go beyond the upper and lower specification limits when the allowable tolerances of Subsection 405.03 F are applied, or outside of the control point upper and lower specification limits specified in Subsection 703.05.

The Contractor must submit all test reports, data, and worksheets used for each trial attempted along with their proposed mix design. The information required must include, but is not limited to, all specific gravity worksheets, Hveem worksheets, ignition oven worksheets with AASHTO T-30 gradations, and immersion compression test worksheets. Air voids, VMA, VFA, asphalt film thickness, and surface area calculation worksheets. Fine aggregate angularity, percent fractured faces, and percent flat and elongated particles worksheets.

The Contractor's mix design will be reviewed for accuracy, completeness, reasonableness, and specifications compliance in accordance with the contract and this section. Review of the mix design does not relieve the Contractor of responsibility for providing a mix design job mix formula and a plant mix pavement that complies with all contractual requirements.

260.01.02 Definitions. The following definitions are from sources common to the hot mix asphalt industry. These items have been selected for further definition because the form of the equation published in the reference text is different than the form used by ITD or additional explanation is warranted.

Bulk Specific Gravity of Aggregate, $\mathbf{G_{sb}}$ the ratio of the weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature.

(AASHTO T-85 and Asphalt Institute Manual Series No. 2 (MS-2). Use AASHTO T-84 and T-85 to determine the bulk specific gravity of fine and coarse aggregates respectively.

When the total aggregate consists of separate fractions of coarse aggregate, fine aggregate, and mineral filler, all having different specific gravities, the bulk specific gravity of the total aggregate is calculated using:

$$G_{sb} = \frac{P_1 + P_2 + \cdots + P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \cdots + \frac{P_n}{G_n}}$$

where G_{sb} = average bulk specific gravity

P_1, P_2, P_n = individual percentages by mass of aggregate, coarse and fine $P_1+P_2+\cdots+P_n = 100$

G_1, G_2, G_n = individual bulk specific gravities of aggregate, coarse and fine.

(Asphalt Institute Manual Series No. 2 (MS-2)

Because the amount of fine aggregate present in the coarse aggregate fraction and the amount of coarse aggregate present in the fine aggregate fraction is very small, this equation can be simplified and written as:

$$\boxed{G_{sb} = \frac{100}{\frac{P_{(+\#4)}}{G_{(+\#4)}} + \frac{P_{(-\#4)}}{G_{(-\#4)}}}}$$

USE THIS EQUATION

where, G_{sb} = average bulk specific gravity

$P_{(+\#4)}, P_{(-\#4)}$, = individual percentages by mass of aggregate, coarse, (+#4) and fine,(-#4)

$G_{(+\#4)}, G_{(-\#4)}$, = individual bulk specific gravities of aggregate, coarse, (+#4) and fine,(-#4)

When more than one materials source is used to provide the coarse aggregate fraction and/or more than one materials source is used to provide the fine aggregate fraction for a mix design or mineral fillers are used, the original form of the Asphalt Institute equation will be used.

***Voids in the Mineral Aggregate,* (VMA)**: the volume of intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume of the sample (Asphalt Institute Manual Series No. 2 (MS-2). VMA can be calculated either as percent by weight of total mix or as a percent by weight of aggregate as follows.

VMA will be calculated using the following formula when the mix composition is **determined as percent by weight of total mixture**:

$$VMA = 100 - \frac{G_{mb} P_s}{G_{sb}}$$

where, VMA = voids in mineral aggregate, percent of bulk volume

G_{sb} = bulk specific gravity of total aggregate

G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166)

P_s = aggregate content, percent by total weight

This formula can also be written as,

$$VMA = 100 - \frac{(G_{mb}\gamma_w)(100 - \%AC)}{G_{sb}\gamma_w}$$

where, ?$_w$ = 62.245, density of water at 77°F

G_{mb} ?$_w$ = Bulk density of compacted mixture

G_{sb} ?$_w$ = Bulk density of total aggregate

P_s = 100-%AC

%AC = asphalt binder content of mixture, in percent by weight of mix.

Finally the equation can be written as,

$$\boxed{VMA = 100 - \frac{(\text{Bulk density of compacted mixture})(100 - \%AC)}{(\text{Bulk density of total aggregate})}}$$ **USE THIS EQUATION**

VMA will be calculated using the following formula when the mix composition is **determined as percent by weight of aggregate**:

$$VMA = 100 - \left[\frac{G_{mb}}{G_{sb}} \times \frac{100}{100 + P_b}\right]100$$

where, VMA = voids in mineral aggregate, percent of bulk volume

G_{sb} = bulk specific gravity of total aggregate

G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166)

P_b or %AC = asphalt content, percent by weight of mix

or,

$$VMA = 100 - \left[\frac{G_{mb}\gamma_w}{G_{sb}\gamma_w} \times \frac{100}{100 + \%AC}\right]100$$

then,

$$\boxed{VMA = 100 - \left(\frac{\text{Bulk density of compacted mixture}}{\text{Bulk density of total aggregate}}\right)\left(\frac{100}{100 + \%AC}\right)100}$$ **USE THIS EQUATION**

***Air Voids,* V_a**: the total volume of small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as a percent of the bulk volume of the compacted paving mixture. (Asphalt Institute Manual Series No. 2 (MS-2).

$$Va = 100 \times \frac{G_{mm} - G_{mb}}{G_{mm}}$$

where, V_a = air voids in compacted mixture, percent of total volume

G_{mm} = maximum specific gravity of paving mixture (AASHTO T-209, Bowl Method)

G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166, Method A) or,

$$Va = 100 \times \frac{G_{mm}\gamma_w - G_{mb}\gamma_w}{G_{mm}\gamma_w}$$

then,

$$\boxed{Va = 100 \times \frac{(\text{max. density of paving mixture}) - (\text{bulk density of compacted mixture})}{(\text{maximum density of paving mixture})}}$$ **USE THIS EQUATION**

***Voids Filled with Asphalt,* (VFA)**: the portion of the volume of intergranular void space between the aggregate particles (VMA) that is occupied by the effective asphalt. (Asphalt Institute Manual Series No. 2 (MS-2).

$$VFA = \frac{100(VMA - Va)}{VMA}$$

where, VFA = voids filled with asphalt, percent of VMA

VMA = voids in mineral aggregate, percent of bulk volume

V_a = air voids in compacted mixture, percent of total volume.

***Asphalt Film Thickness*, (AFT)**: The calculated film thickness is an average film thickness which has been generally correlated with durability. If the asphalt cement film is too thin, air which enters the compacted HMA can more rapidly oxidize these thin films, causing the HMA to become brittle and to fail prematurely by cracking. Additionally, if the aggregates are susceptible to water damage, thin films are more easily and rapidly penetrated by water than thick ones producing the typical manifestations of water damage: rutting, shoving, raveling, and bleeding. The average asphalt film thickness is calculated using the following formula as published in the National Center for Asphalt Technology publication Hot Mix Asphalt Materials, Mixture Design and Construction, Second Edition 1996 (F. L. Roberts, P. S. Kandhal, E. R. Brown, D. Lee and T. W. Kennedy).

$$AFT = \frac{V_{asp}}{SA \times W}(304{,}800)$$

where, AFT = Asphalt film thickness,(microns)

V_{asp} = effective volume of asphalt cement, (Cubic feet)

SA = surface area of the aggregate (square feet per pound of aggregate)

W = weight of aggregate (pounds)

or, W = (bulk density of compacted mix)(100-%AC)

304,800 = constant, $\frac{1000 \text{ microns}}{\text{mm}} \times \frac{25.4 \text{ mm}}{\text{inch}} \times \frac{12 \text{ inches}}{\text{foot}} = \frac{304{,}800 \text{ microns}}{\text{foot}}$

To determine the value of the effective volume of asphalt cement, V_{asp}:

V_{asp} is equal to the total volume of asphalt binder minus the absorbed volume of binder,

or

V_{asp}= Total volume of asphalt - Volume of absorbed asphalt and,

$$\text{Total volume of asphalt} = \frac{(\text{bulk density of compacted mix})(\%\ \text{AC})}{G_b\gamma_w}$$

where G_b = Specific gravity of asphalt binder
?$_w$ = 62.245, density of water at 77°F

and, Absorbed Asphalt, by weight of aggregate is determined by:

$$P_{ba} = 100 - \frac{G_{se} - G_{sb}}{G_{sb}G_{se}} G_b$$

where, P_{ba} = Absorbed asphalt, by weight of aggregate
G_{se} = Effective Specific Gravity of Aggregate

then,

$$\text{Weight of Absorbed asphalt} = (P_{ba})(\text{bulk density of compacted mix})(\%\ \text{aggregate})$$

where,

$$\%\ \text{aggregate} = 100 - \%\text{AC}$$

and,

$$\text{Weight of Absorbed asphalt} = (P_{ba})(\text{bulk density of compacted mix})(100 - \%\ \text{AC})$$

therefore,

$$\text{Volume of Absorbed Asphalt} = \frac{(\text{Weight of absorbed asphalt})}{G_b\gamma_w}$$

finally,

$$\boxed{V_{asp} = \frac{(\text{Bulk density of compacted mix})(\%\text{AC})}{G_b\gamma_w} - \frac{(\text{Weight of Absorbed asphalt})}{G_b\gamma_w}}$$ **USE THIS EQUATION**

***Surface Area,* (SA)**: The aggregate surface area is important since it affects the amount of asphalt needed to coat the aggregate. Dense-graded asphalt mixtures are usually designed to contain a desires amount of air voids; hence, the aggregate surface area is not a design factor. It is possible to increase the surface area of an aggregate and at the same time reduce the optimum asphalt content. One way to do this is by increasing the dust content, (minus# 200) of a mixture. Asphalt mixtures that have a high surface area and low optimum asphalt content are undesirable because these mixes will have thin asphalt film on the aggregate and will probably not have adequate durability.

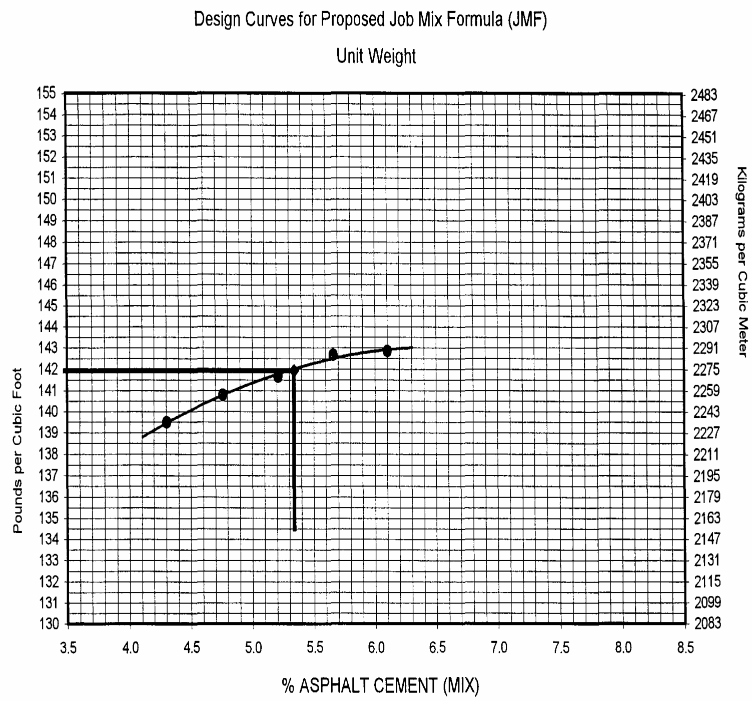
One of the primary reasons for estimating the surface area is to determine the asphalt film thickness. This is an estimate value, but it does allow comparisons to be made for various mixtures. (National Center for Asphalt Technology publication Hot Mix Asphalt Materials, Mixture Design and Construction, Second Edition 1996 (F. L. Roberts, P. S. Kandhal, E. R. Brown, D. Lee and T. W. Kennedy).

Sieve size	Surface Area Factor
Percent Passing Maximum Sieve Size	2
Percent Passing No. 4	2
Percent Passing No. 8	4
Percent Passing No. 16	8
Percent Passing No. 30	14
Percent Passing No. 50	30
Percent Passing No. 100	60
Percent Passing No. 200	160

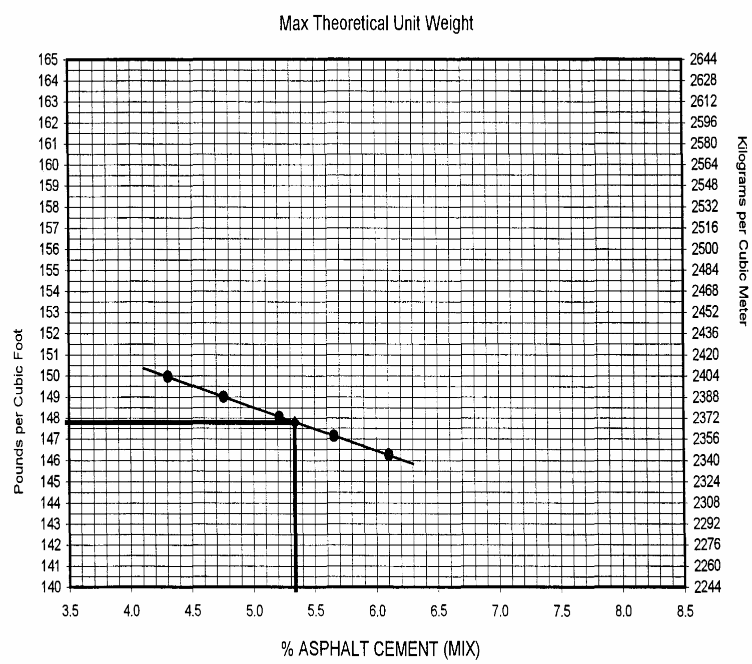
$$SA = 2\times(\%\ \text{Passing Max Sieve Size}) + 2\times(\%\ \text{Passing No. 4}) + 4\times(\%\ \text{Passing No. 8}) + 8\times(\%\ \text{Passing No.16}) + 14\times(\%\ \text{Passing No.30}) + 30\times(\%\ \text{Passing No.50}) + 60\times(\%\ \text{Passing No.100}) + 160\times(\%\ \text{Passing No. 200})$$

260.01.03 Examples. The following examples show typical plant mix pavement mix design curves that are generated during the mix design process. The graphs illustrate how the information should be analyzed to determine acceptability.

Figure 260.01.03.1A

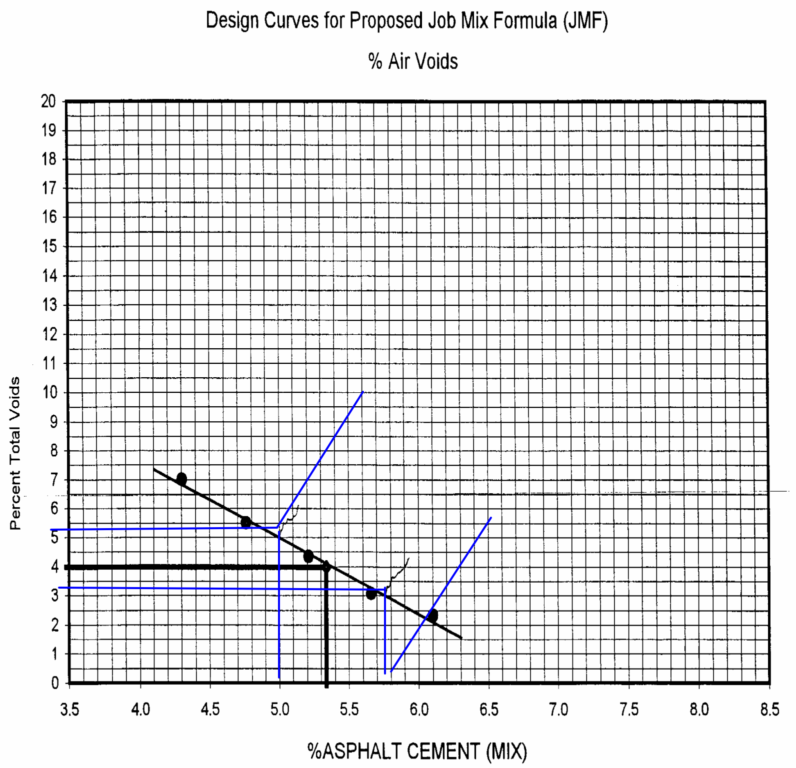


This graph shows how the unit weight of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate bulk density of the compacted mix at a given asphalt content.

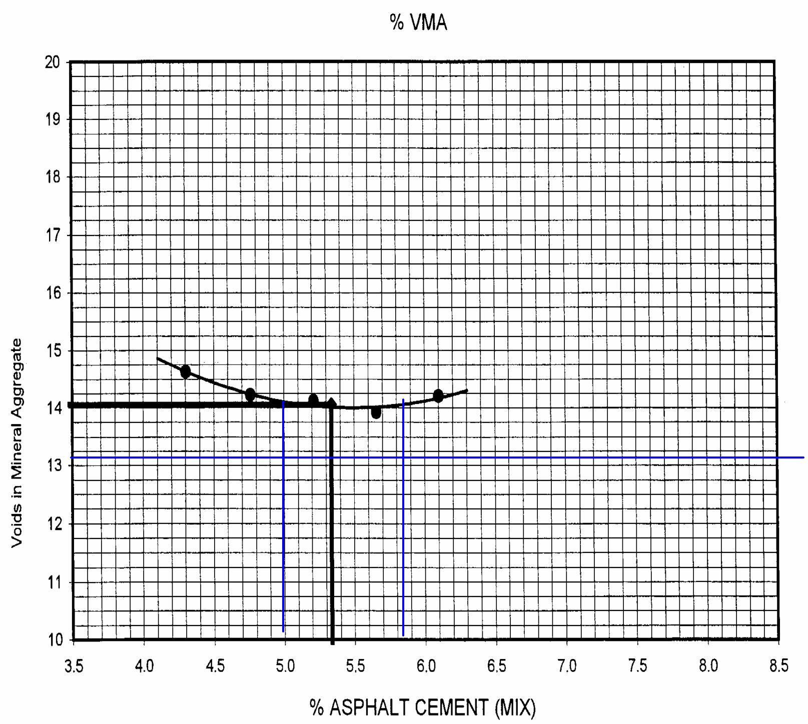


This graph shows how the maximum theoretical unit weight (Rice) of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate Rice density of the compacted mix at a given asphalt content. The weight goes down as the asphalt content goes up.

Figure 260.01.03.1B

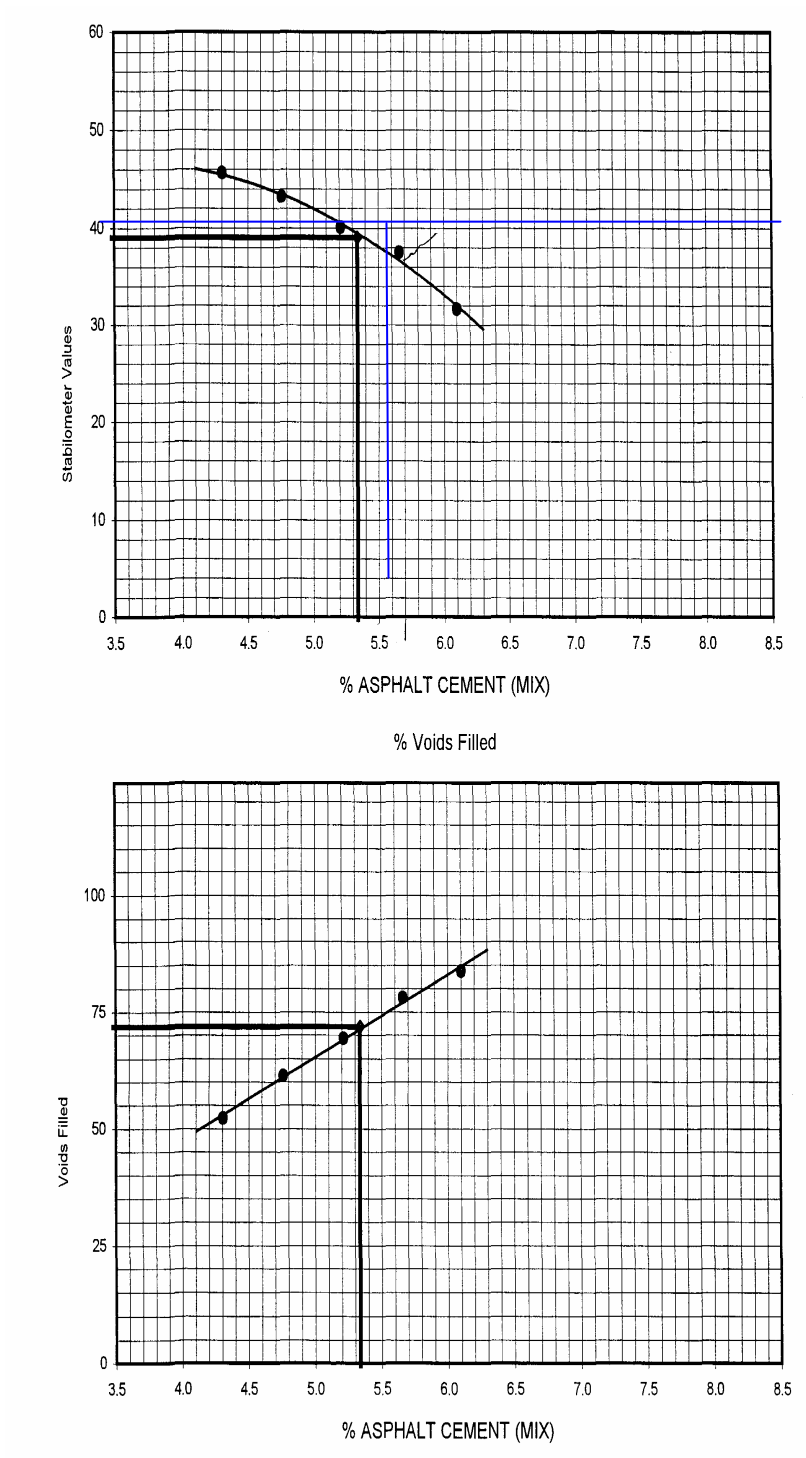


Step 1. Find the asphalt binder percent at 3% and 5% total Air Voids. Select 5% air Voids on the vertical axis and project a line to the left until it intercepts the curve. Then project the line down to the % asphalt binder on the horizontal axis. Do the same with 3% air voids. This mix has a range of asphalt contents of between 5.0 and 5.75% or a range of 0.75% which is greater than 0.4% and meets the specification, so far.



Step 2. Check the VMA at the % asphalt binder range determined in Step 1. For this mix design, the VMA is greater than the minimum of 13.0 over the entire range of asphalt contents determined in Step 1. This mix still has an acceptable AC range of 5.0 to 5.75%

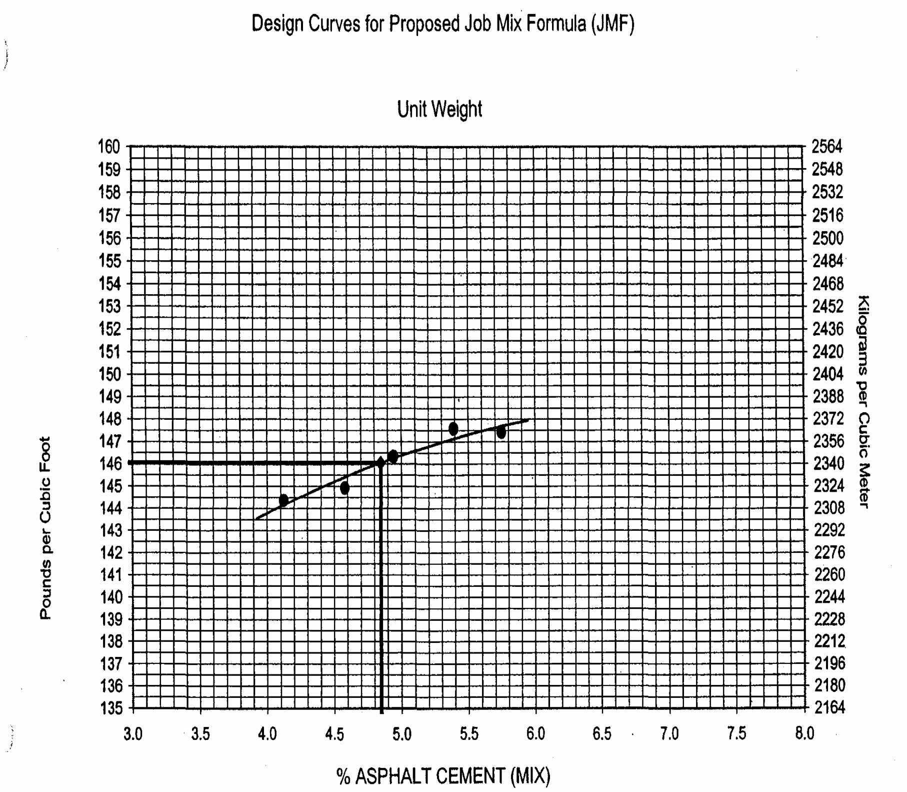
Figure 260.01.03.1C



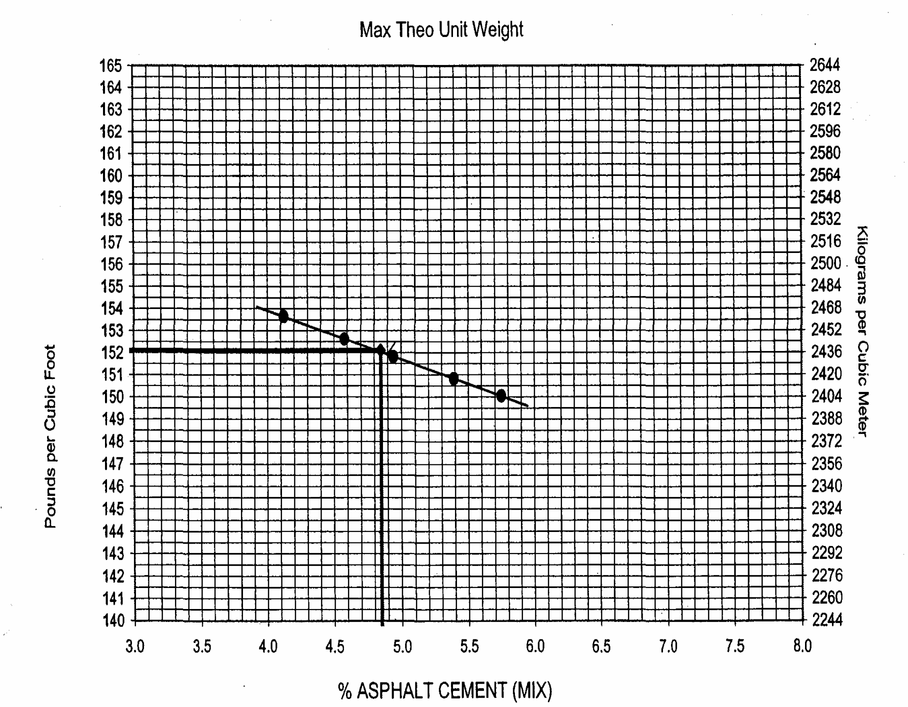
Step 3. Check the stability of the mix over the range of asphalt contents determined in the previous two steps. Draw a line horizontally at the minimum stability value, (37 for this mix), on the vertical axis that intercepts the stability curve. In this mix, the stability falls below the minimum allowed number of 37 at an asphalt content of 5.65%. Stability is within specification up to 5.65% asphalt and is out of specification at higher asphalt contents so the asphalt content range for this mix design that meets all the specification requirements of Subsections 405.02 and 405.03 is 5.0 to 5.65. This range 0.65% exceeds the 0.40% required in the specification.

VFA, Voids Filled With Asphalt is not currently a design criteria. VFA is inversely related to air voids and should be around 50 to 70%. When it exceeds approximately 80 to 85% rutting is likely to occur.

Figure 260.01.03.2A

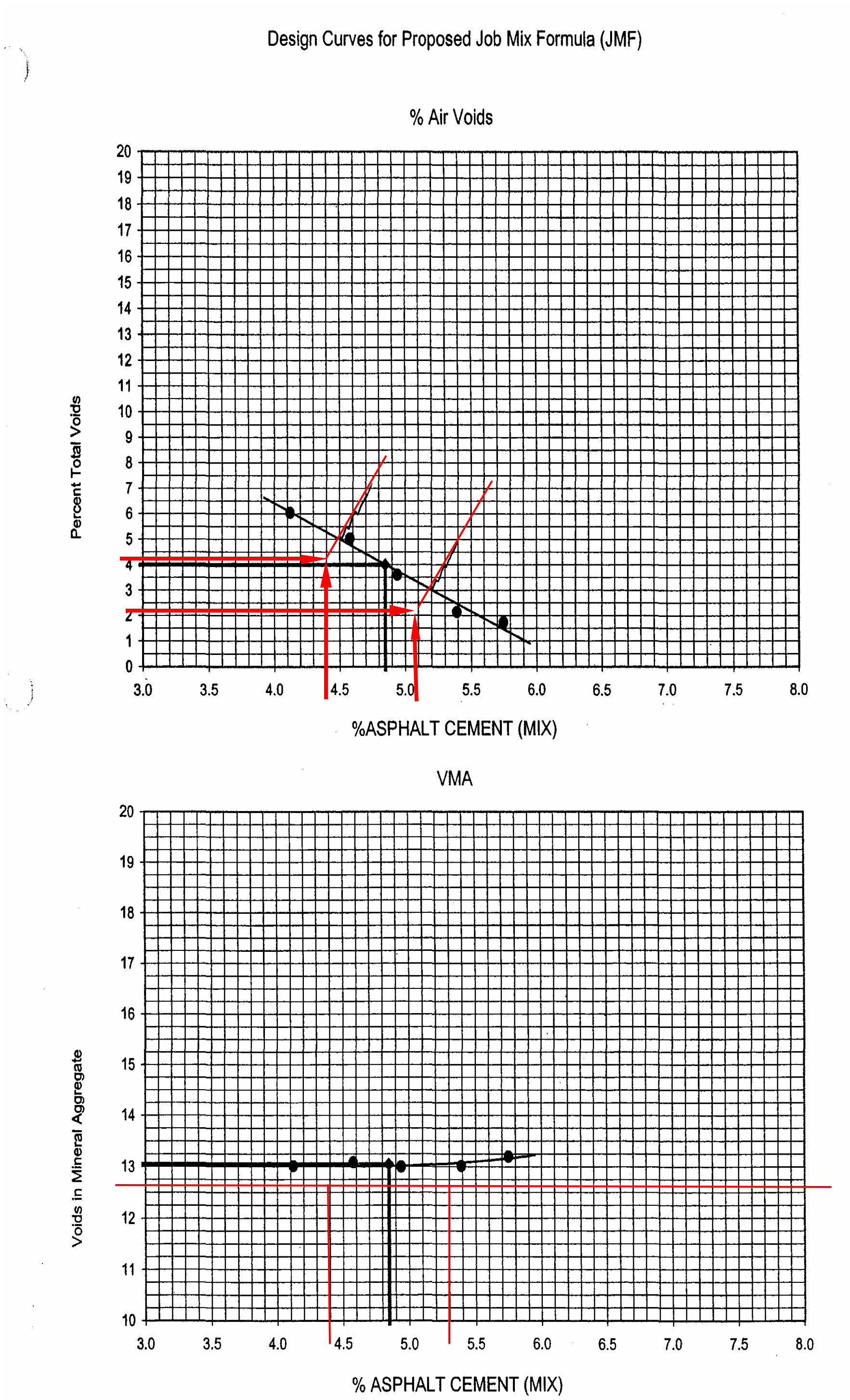


This graph shows how the unit weight of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate bulk density of the compacted mix at a given asphalt content.



This graph shows how the maximum theoretical unit weight (Rice) of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate Rice density of the compacted mix at a given asphalt content. The weight goes down as the asphalt content goes up.

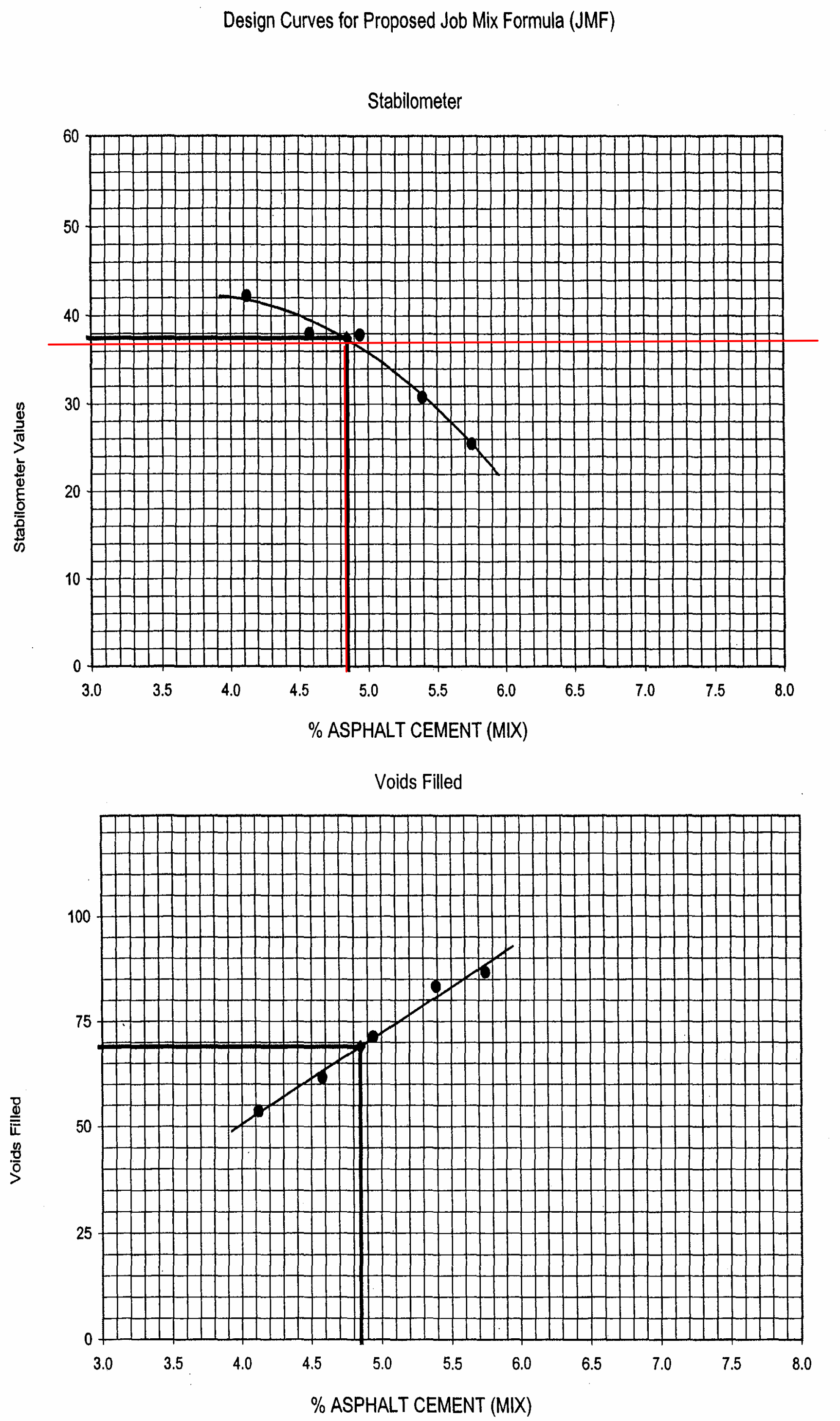
Figure 260.01.03.2B



Step 1. Find the asphalt binder percent at 3% and 5% total Air Voids. Select 5% air Voids on the vertical axis and project a line to the left until it intercepts the curve. Then project the line down to the % asphalt binder on the horizontal axis. Do the same with 3% air voids. This mix has a range of asphalt contents of between 4.5 and 5.2% or a range of 0.7% which is greater than 0.4% and meets the specification so far.

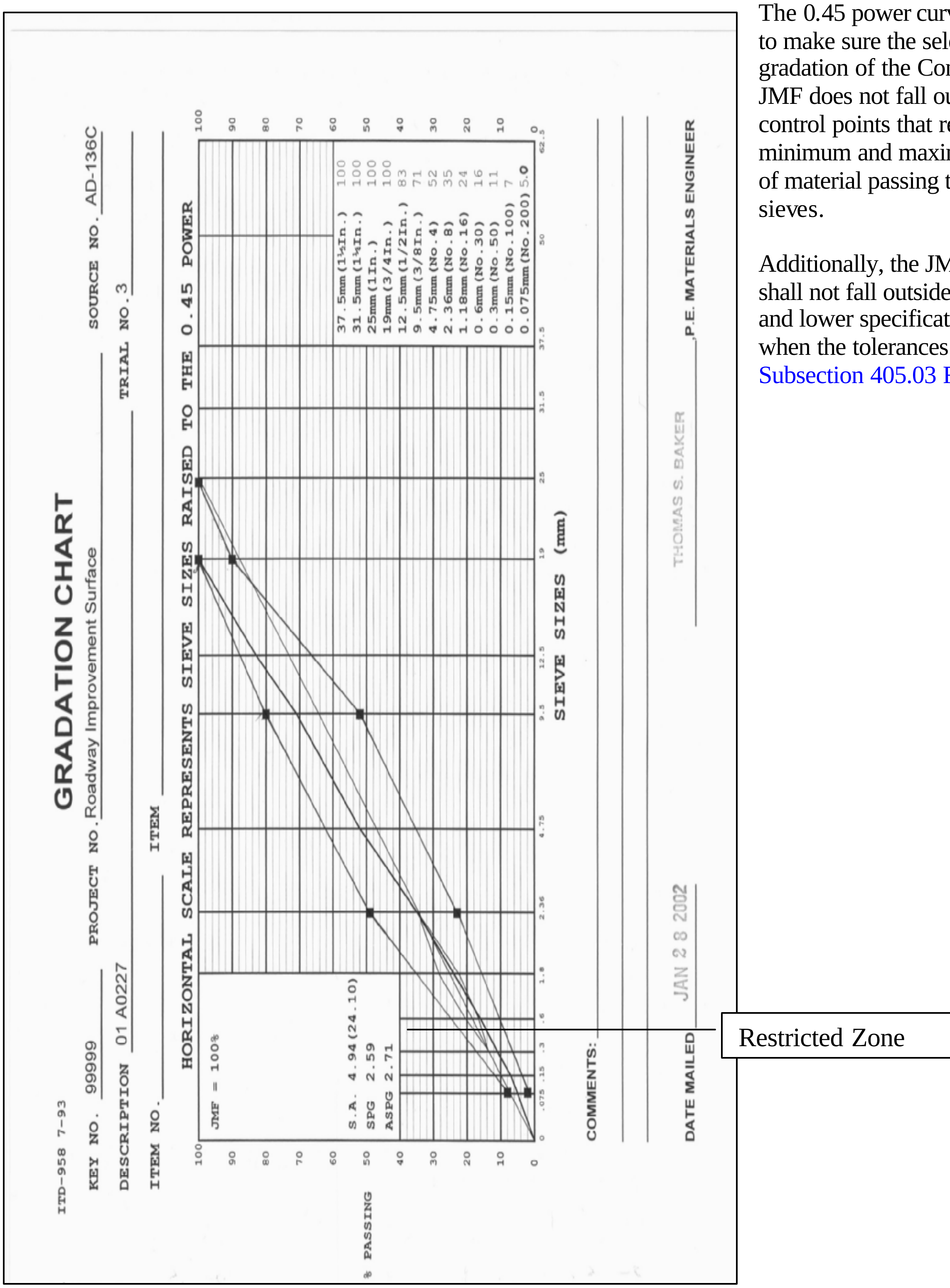
Step 2. Check the VMA at the % asphalt binder range determined in Step 1. For this mix design, the VMA curve is right on the minimum of 13.0 over the entire range of asphalt contents determined in Step 1. This mix still has an acceptable AC range of 4.5 to 5.4 %. This mix could have VMA problems based on this curve.

Figure 260.01.03.2C



Step 3. Check the stability number over the range of asphalt contents determined in the previous two steps. Draw a line horizontally from the minimum stability value, (37 for this mix), on the vertical axis that intercepts the stability curve. In this mix, the stability falls below the minimum allowed number of 37 at an asphalt content of 4.9%. Stability is within specification up to 4.9% asphalt and is out of specification at higher asphalt contents so the asphalt content range for this mix design that meets all the specification requirements of Subsections 405.02 and 405.03 is 4.5 to 4.9%. This range 0.4% meets the 0.40% required in the specification. Stability of the mix could be a problem if the asphalt content goes higher than 4.9%.

Figure 260.01.03.3. 0.45 Power Curve



The 0.45 power curve is checked to make sure the selected gradation of the Contractor's JMF does not fall outside the control points that represent the minimum and maximum amount of material passing the control sieves.

Additionally, the JMF gradation shall not fall outside the upper and lower specification limits when the tolerances of Subsection 405.03 F are applied.

260.02 Concrete Pavement (Standard Specification Section 409). Mix designs will be reviewed or confirmed according to the contract requirements.

260.02.01 Portland Cement Concrete Pavement. Central Materials Laboratory will confirm concrete mix designs for Portland Cement Concrete Pavement in accordance with the following procedures.

All sampling and testing performed shall be in accordance with the sampling and testing methods as specified in the ITD Standard Specifications.

260.02.01.01 Items Provided to Central Materials Laboratory. The following items must be received by the Central Materials Laboratory before the concrete mix design confirmation process will be initiated. All samples submitted to the Central Materials Laboratory must be accompanied by a completed ITD-1044. These items must be submitted 60 days in advance of proposed use:

1. A complete mix design including specific gravity (SSD) and absorption for both fine and coarse aggregates per AASHTO T-84 and T-85, respectively. The mix design must identify the aggregate source that will be used and the aggregate correction factor per AASHTO T-152.
2. For concrete aggregate sources identified during source approval as reactive per AASHTO T303 baseline testing, ASTM C1293, or ASTM C295 the mix design must include AASHTO T303 (modified) test results for mitigation of ASR expansion.
3. Gradation test results representing the material that will be used.
4. Samples of the proposed aggregate, cement and admixtures. A minimum of 350 pounds of coarse aggregate, 200 pounds of fine aggregate and 100 pounds of cement must be supplied to the Central Materials Laboratory. No one sample container may weigh more than 50 pounds. All materials provided must meet the contract specifications.
5. Mill analysis test reports from the manufacturer must be included for the cement, fly ash and/or silica fume submitted.
6. Copies of all data, test reports and worksheets associated with the mix design.
7. Each mix design must be assigned a unique mix identification number identical to that which will be recorded on all batch tickets for concrete batched according to the mix design.

260.02.01.02 Central Materials Laboratory Procedures. The Central Materials Laboratory will complete the following prior to batching the proposed mix design:

1. Verify the Contractor's compressive strength test results are based on the average of three 28-day cylinders and indicate a minimum compressive strength of 5600 psi. If this requirement is not met the mix design will not be confirmed.
2. For aggregate sources identified as reactive for ASR, verify the Contractor's ASR mitigation expansion testing (modified AASHTO T303) meets the following requirements. If these requirement are not met, the mix design will not be confirmed.
   a. Expansion of mortar bars shall not exceed 0.10 percent at 14 days with the addition of fly ash, lithium, or other ASR mitigation additives.
   b. The aggregate blend percentages used in the testing are reported and are within 2% of the blend percentages proposed in the mix design and to be used on the project. Coarse and fine aggregates may also be tested separately.
   c. The materials used in the expansion testing are the same materials (aggregate sources, cement, fly ash, mitigation additive) and at the same proportions reported in the proposed mix design and to be used on the project.

d. When lithium is used, ensure the lithium dosage is reported as a volume and as a percent of the standard or full dose.

3. Verify the aggregate is from an approved aggregate materials source. If the source has not been approved, no further testing will be conducted until source approval has been obtained.
4. Check the mix design for conformance with the contract specifications (ie. cement content, air, slump, etc.). The design volume will be checked to ensure it totals 27 cubic feet. Should the mix design not meet contract requirements the mix design confirmation process will not proceed and the mix design will not be confirmed.
5. Test the fine aggregate for gradation and sand equivalent. Verify the specific gravity and absorption of the coarse and fine aggregate. Should the gradation or sand equivalent testing indicate the aggregate does not meet the contract specifications, the mix design confirmation process will be halted until acceptable materials are submitted.
6. Additional testing of the individual materials (cement, aggregates, fly ash, silica fume, admixtures) may be conducted to verify conformance with contract specifications.

The Central Materials Laboratory will batch the concrete in accordance with ASTM C192/C 192M at the proportions indicated in the Contractor's mix design submittal. Admixture dosages may be adjusted in accordance with the manufacturer's recommendations to achieve desired mix parameters. Coarse aggregate will be separated into individual-sized fractions and recombined to produce the gradation indicated in the Contractor's submittal. The weight of coarse and fine aggregate to be used in the batch will be determined per sections 6.3.2.2 and 6.3.2.3 of ASTM C192/C 192M, respectively.

The following mixing sequence will be used by the Central Materials Laboratory unless otherwise agreed to in writing:

1. Add coarse aggregate, ¾ of the mix water and the air entraining agent (if required) dispensed in solution with the mix water and mix.
2. Add fine aggregate, cement and flyash (if required) and mix.
3. Add ¼ of the mix water and the water reducing agent (if required) dispensed in solution with the mix water and mix.

If additional admixtures and/or silica fume are used in the mix they will be added in the above sequence per the manufacturer's written recommendations.

The above mixing sequence will not be altered unless the alternate sequence is pre-approved in writing by the admixture manufacturer(s) and the approved alternate mix sequence is provided with the mix design submittal. It is strongly recommended that all laboratories performing mix designs follow the mixing sequence as described above, so test results between labs will be as consistent as possible, and to enable the mix design confirmation process to be completed in as timely a manner as possible.

After mixing, the concrete will be tested for slump, air content, unit weight and yield. Cylinders will be prepared for compressive strength testing.

For mixes using aggregates that are identified as ASR reactive, the Central Materials Laboratory may conduct AASHTO T303 (modified) testing using the proposed mitigation admixtures to confirm the Contractor's testing.

260.02.01.03 Confirmation. The Contractor's mix design will be confirmed for strength provided the Central Materials Laboratory's compressive strength test results, based on the average of three 28-day cylinders, indicate a **minimum** compressive strength of 5300 psi.

When applicable, the Contractor's mix design will be confirmed for ASR mitigation provided the Central Materials Laboratory's expansion test results indicate contract specifications are met (0.10% expansion or less at 14 days) or are within the established multi-laboratory precision of the Contractor's passing expansion test results.

The mix design confirmation results will be reported to the District Resident/Regional Engineer via memo from the HQ Materials Section.

260.03 Structural Concrete (Standard Specification Section 502). All sampling and testing methods performed shall be as specified in the ITD Standard Specifications. Concrete mix design approval requires concurrence by the District Materials Engineer.

260.03.01 Approval Procedures. Complete the following:

1. Verify the complete mix design submittal for conformance with the contract specifications. Designs that do not meet ITD project requirements and specifications will not be approved for use.
2. The mix design must identify an approved aggregate source(s) that will be used and the aggregate correction factor, (AASHTO T-152).
3. For aggregate sources that are reactive according to AASHTO T-303 baseline testing, ASTM C1293 or ASTM C295 review the modified AASHTO T-303, Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction (mitigation efforts for ASR expansion) test reports.
4. For aggregate sources identified as reactive for ASR, concrete mix design approval requires the following requirements be met for the modified AASHTO T303 mitigation testing:
    a. Expansion of mortar bars shall not exceed 0.10 percent at 14 days with the addition of fly ash, lithium, or other ASR mitigation additives.
    b. The aggregate blend percentages used in the testing are reported and are within 2% of the blend percentages proposed in the mix design and to be used on the project. Aggregates may also be tested separately.
    c. The materials used in the expansion testing are the same materials (aggregate sources, cement, fly ash, mitigation additive) and at the same proportions reported in the proposed mix design and to be used on the project.
    d. When fly ash is used, ensure the calcium oxide content of the fly ash used on the project meets the 2% tolerance as established by the specifications.
    e. When lithium is used, ensure the lithium dosage is reported as a volume and as a percent of the standard or full dose.
5. Mill analysis test reports from the manufacturer must be included for the cement, fly ash, and/or silica fume, meet contract specifications and be the same material to be used on the project. Check that any admixtures are approved. The Central Lab in Boise keeps an updated qualified products list for concrete admixtures.
6. Verify that Basic Mix Strength and Design Mix Strength have been determined per Subsection 502.03 of the Specifications. Basic mix strength must equal or exceed the design mix strength calculated for the specified class of concrete. Class 15 and 22 are exempt from this requirement.
7. Each mix design shall be assigned a unique mix identification number identical to that which will be recorded on all batch tickets for concrete batched according to the mix design.

8. Check the absolute volume of the mix design. Yield should be checked with air in the mid-range. Verify that the moisture content of the aggregate is included in the water content. In addition, efforts to mitigate ASR using lithium nitrate admixture will increase the water content in the mix and must be adjusted for.
9. Calculate the volume using the maximum air content to insure that the cement factor does not fall below specifications. (Do not base the mix design using maximum air for anything but checking cement content.)
10. Check the percentage of sand based on total weight of aggregate. Generally, this percentage is 30% to 42%. (When sand exceeds 42%, the slump will become more difficult to achieve and maintain because the surface area of the aggregate has increased and requires a larger volume of paste. If during mix design, additional water is used to get the slump and workability, then the w/c ratio goes up. The yield goes up, the cement content goes down, and strength goes down.)
11. The water-cement ratio should be designed at a realistic figure for the strength/class of concrete needed. At no time should the water cement ratio be based on the maximum allowable specification. If the upper end of the water-cement ratio is to be targeted, stay at least 0.02 under the maximum specification, allowing for fluctuation in batch weights.
12. If fly ash is used, up to 25% of total cementatious material (cement and fly ash) may be fly ash as per specifications. The specific gravity of the fly ash is required. The weight of fly ash is added to the weight of cement when calculating cement content and the water cement ratio.

Attached is an example of ITD-907 Concrete Mix Design Review for Structural or Pavement Design.

Example

ITD-907 4-90

CONCRETE MIX DESIGN REVIEW FOR STRUCTURAL OR PAVEMENT DESIGN

SHEET 1 OF ____

PROJECT NO. IR-84-2(035)95 COUNTY Elmore
CONCRETE SUPPLIER ACME SOURCE NO. EL-116
CONTRACT ITEM NO. 409 CONCRETE, CLASS 45 (5600/28 day)
CONCRETE MIX DESIGN NO. 3 DATE 7/14/97

CLASS OF CONCRETE IN 100 PSI	MINIMUM CEMENT CONTENT LB./C.Y.	MINIMUM FLY ASH CONTENT LB./C.Y.	MAX. W/C + FLY ASH RATIO LB./LB.	% AIR CONTENT	A.E.A. OZ./C.Y.	SLUMP RANGE, INCHES	COARSE AGGR. SIZE
56	467	116	0.47	4-7		½-2	3

AGGREGATE BULK SPECIFIC GRAVITY (~~DRY~~) OR (SSD) ★	% ABSORP.	LABORATORY NUMBERS	% BLEND EACH SIZE
COARSE ...... = 2.57	1.2	CRSE. ______	______
FINE .... = 2.61	1.8	CRSE. ______	______
BLEND SAND= ______	______	FINE ______	______
		FINE ______	______

% SAND = $\frac{Mc - M}{Mc - Mf}$ = R = . ______ or 34.5 %

W/C = 0.40

ABSOLUTE VOLUME METHOD for DESIGN of CONCRETE

YIELD = 27 CU. FT./CU. YD. .... = 27.000 C.F. = Y

WATER = 28 GAL./CU. YD. ÷ 7.48 .... = 3.743 C.F. = W

CEMENT = $\frac{\text{LB./C.Y.}}{3.15 \times 62.4}$ = $\frac{467}{196.56}$ .... = 2.376 C.F. = C

FLY ASH = $\frac{\text{LB./C.Y. } 116}{\text{SP.GR. } 2.240 \times 62.4}$ .... = 0.830 C.F. = FLY ASH

Y......... = 27.000 C.F. —

AIR = Y X % AIR design at max 7% = 1.89 C.F. = A

W + C + FLY ASH + A .... = 8.839 C.F.

Y - (W + C + FLY ASH + A) ...... = 18.161 C.F. = C.A. + F.A.

(C.A. + F.A.) X R .... = 6.266 C.F. = F.A.

(C.A. + F.A.) - F.A. .... = 11.895 C.F. = C.A.

COARSE = C.A. X SP. GR. X 62.4 .... = 1908 LB. (~~DRY~~)(SSD) ★

FINE = F.A. X SP. GR. X 62.4 .... = 1020 LB. (~~DRY~~)(SSD) ★

BLEND SAND X SP. GR. X 62.4 .... = —— LB. (DRY)(SSD) ★

BASIC BATCH WEIGHTS FOR A CUBIC YARD BATCH	BATCH WEIGHTS CORRECTED FOR ABSORPTION	MOISTURE	BATCH WEIGHT
CEMENT .. 467 LB.	467 LB.	____ LB.	467 LB.
FLY ASH .. 116 LB.	116 LB.	____ LB.	116 LB.
WATER .... 234 LB.	275 LB.	____ LB.	275 LB.
COARSE .. 1908 LB. (~~DRY~~) (SSD) ★	1885 LB.	(x) ____ LB.	1885 LB. (DRY) (~~SSD~~) ★
FINE .... 1020 LB. (~~DRY~~) (SSD) ★	1002 LB.	(z) ____ LB.	1002 LB. (DRY) (~~SSD~~) ★
BLEND SAND —— LB. (DRY) (SSD) ★	—— LB.	—— LB.	—— LB. (DRY) (SSD) ★

DETERMINATION OF THE YIELD

TOTAL BATCH WEIGHT (DESIGN) .... = 3,745 LB.

WEIGHT PER CUBIC FOOT (DESIGN) .... = 138.7 LB.

WEIGHT PER CUBIC FOOT (FRESH CONCRETE) .... = 138.8 LB.

$\frac{\text{TOTAL BATCH WEIGHT}}{\text{WT./CU. FT. FRESH CONC.}}$ = 26.981 CU. FT. (VOLUME OF CONCRETE PRODUCED)

$\frac{\text{VOLUME OF CONCRETE PRODUCED}}{\text{NUMBER OF YARDS} \times 27}$ = 0.999 RELATIVE YIELD.

CORRECTION FOR ABSORPTION

% ABSORP. X LB. C.A. .... = 22.9 LB. WATER
% ABSORP. X LB. F.A. .... = 18.4 LB. WATER
BLEND SAND .... = —— LB. WATER
INCREASE THE MIXING WATER BY THE SUM OF THESE THREE .... = 41.3 LB. WATER

CORRECTION FOR MOISTURE CONTENT

% MOISTURE IN C.A. X LB. COARSE AGGR. .... = ______ LB. WATER (X)
% MOISTURE IN F.A. X LB. FINE AGGR. .... = ______ LB. WATER (Z)
DECREASE THE MIXING WATER BY THE SUM OF THESE TWO .... = ______ LB. WATER
INCREASE THE WEIGHT OF THE C.A. BY (X).
INCREASE THE WEIGHT OF THE F.A. BY (Z).

★ CROSS OUT EITHER DRY OR SSD AS APPROPRIATE.
FINAL ACCEPTANCE IS CONTINGENT UPON ACCEPTANCE OF AIR CONTENT, SLUMP AND STRENGTH.

COMPUTED BY D. T. CHECKED BY Mk DATE 7/14/97

SECTION 265.00 – QUALIFIED AGGREGATE MATERIAL SUPPLIERS

The District Materials Engineer will maintain current lists of qualified aggregate material suppliers. The lists will be divided by the aggregate product category. To be included on a list means the aggregate supplier has provided the state with adequate documentation to verify conformance with state specifications, including but not limited to Standard Specification Sections 106.09, 107.02, 107.17, 107.18, 703.12, and 703.13. Sampling and testing will be by an approved independent laboratory. The purpose of having the current lists is to provide ITD personnel and contractors with readily available information regarding aggregate suppliers that have met the requirements for aggregate quality and source clearance. The availability and quantity of the material in the source is not to be implied.

The lists do not imply acceptance of material should the quality change or the material not meet the contract requirements. The material must meet the contract requirements for acceptance.

The Resident/Regional Engineer has the authority to grant written approval for a contractor to use an aggregate source from the qualified material suppliers list for a specific project, providing the District Materials Engineer concurs.

The aggregate supplier's source will be identified by pit number and location. Combining stockpiles or aggregates from other sources that are not qualified will invalidate the qualification. The source may be included on the list for a period of not more than two years before the source must be re-evaluated by the District Materials Engineer. The re-evaluation will be based on the suppliers' current operation and adequate documentation provided by the supplier, including new test results when necessary, to determine specification compliance. An aggregate source may be removed from a list at any time should evidence of noncompliance exist.

Refer to Subsection 106.09-II, Contractor Furnished Source, in the Contract Administration Manual for administration of source approval.

265.01 Qualified Asphalt Mix Aggregate and Base Aggregate Suppliers. The District Materials Engineer will evaluate the source based on Standard Specifications Section 703 – Aggregates, and applicable asphalt mix specification requirements. In no case will inclusion on the list imply approval of a mix design, job-mix formula, or specification material.

Mix designs or job-mix formulas will be evaluated separately for each project based on Standard Specification Section 405.03(A) or QA Special Provisions.

265.02 Qualified Concrete Aggregate Suppliers. The District Materials Engineer will evaluate the source based on Standard Specifications Section 703 – Aggregates, and applicable concrete specification requirements and notify the supplier if the source is qualified to be included on the list. Inclusion on the list does not imply approval of a concrete mix design or specification material.

265.03 Other Specification Aggregate Items. Other aggregate items not included in the base, asphalt mix, or concrete categories that have quality requirements may be listed as qualified, providing the supplier submits adequate documentation to the district for evaluation to verify specification conformance.